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Validities of tests given in July 1948 for predicting first year average grades at the U.S. Naval Postgraduate School

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Educational Testing Service

RESEARCH BULLETIN

VALIDITIES OF TESTS GIVEN IN JULY 1948 FOR PREDICTING FIRST YEAR AVERAGE GRADES AT THE U. S. NAVAL POSTGRADUATE SCHOOL

Report prepared by William G. Mollenkopf

Educational Testing Service

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ABSTRACT

Scores on the twenty aptitude and achievement tests administered in July 1948 to the incoming class at the U. S. Naval Postgraduate School have been related to the quality-point ratios of the officers in this class for their entire first year. Charts have been prepared showing for each of four score intervals on each test the percentage of students having such test scores who earned quality-point ratios above 2.00. Also, product-moment coefficients of correlation between scores on each test and the criterion of quality-point ratios have been computed.

Examination of the charts and consideration of the correlations presented in this report reveal that the tests which showed high relationships with the academic grades were those in mathematical aptitude and mathematical achievement, engineering, reading comprehension, and physics.

It was concluded that a very promising start has been made on the task of developing a battery of tests suitable for use as part of the means of selecting students for the Naval Postgraduate School.

Validities of Tests Given in July 1948 for Predicting First Year Average Grades at the U. S. Naval Postgraduate School

Introduction

Twenty aptitude and achievement tests were administered in July 1948 to the officers of the incoming class at the U. S. Naval Postgraduate School. Since this constituted the first step in the development of a test battery for use as part of the means of selecting officers for attendance at the School, these tests were so chosen as to cover a very wide range of abilities. As the first means of judging the effectiveness of these tests, the relationships between scores on the various tests and average grades for the first two terms were obtained. A report dated April 1949 presented these results. The present report deals with the corresponding results obtained when the quality-point ratios for the entire first year at the School were used as the criterion measures.

Descriptions of the Tests

In the interpretation of the results to be presented in the following section, brief descriptions of the twenty tests may be of considerable value.

1. Engineering Achievement Test in Mathematics, Form B. This test consisted of 60 questions in algebra, plane analytic geometry, trigonometry, differential calculus, and integral calculus. The time limit was two hours.

2. Physics Test, Form 8A. This was a College Entrance Examination Board Achievement Test in Physics. It contained 60 questions on topics covered in the usual high-school course in physics. The time limit was 60 minutes.

3. Advanced Test in Engineering (Form A) of the Graduate Record Examination. This was a specialized test in engineering designed to be given to seniors in colleges of engineering or to first-year graduate students. There were 140 questions. The time limit was 105 minutes.

4. Verbal Antonyms, Subtest One of the College Entrance Examination Board Scholastic Aptitude Test, Form TA. The questions in this test required the student to indicate which two out of a group of four words were most nearly opposite in meaning. There were 80 questions. The time limit was 25 minutes.

5. Reading Comprehension, Form WNPA. This was a test especially prepared for use at USNPGS. The test consisted of six passages of scientific reading material each of which was followed by a set of questions to be answered on the basis of what was stated or implied in the passage. There were 30 questions in all, and the time limit was 30 minutes.

6. Mathematics Test, Subtest 4 of the College Entrance Examination Board Scholastic Aptitude Test Form WSA2 (Program 1). This was a mathematical aptitude test designed to minimize the effects on the score of length and recency of formal training in mathematics. The test contained 35 questions, and the time limit was 30 minutes.

7. Mathematics Test, Subtest 6 of the College Entrance Examination Board Intermediate Mathematics Test, Form WIM3. This was a high-school level test in mathematics, and contained 25 questions in arithmetic, plane geometry, and high-school algebra. The time limit was 30 minutes.

8. Multiple Variates, VDPH Book 2, Section II. This was a quantitative aptitude test consisting of 25 items in which the student was called upon to state for each of many small tables what algebraic relationship existed between the columns of numbers in these tables. The time limit was 25 minutes.

9. Picture Equations, VDPH Book 4, Section III. That was another quantitative aptitude test, consisting of items involving equations mostly presented in pictorial form. The student was given a table of the relations among the pictured elements and was called upon to indicate what quantity was needed for addition to one side of the equation so that it would balance. There were 20 problems and the time limit was 20 minutes.

10. Spatial Relations: Intersections, College Entrance Examination Board VAC1, Part I. Each item in this test showed a drawing of a solid figure cut by a plane. The student was called upon to select from five figures presented him the one which correctly represented the shape on the cutting plane of the intersection between the solid figure and this plane. There were 60 items. The time limit was 30 minutes.

11. Spatial Relations: Identical Blocks, College Entrance Examination Board VAC1, Part II. Each item in this test showed a solid block of some particular shape, to the right of which there were five other blocks. The student was asked to identify which one of these five was the same as the problem block, but seen from a different point of view. There were 30 items, and the time limit was 30 minutes.

12. Mechanical Movements, WNPA. The questions in this test were based upon numerous line drawings of mechanical devices involving cams, gears, pulleys, levers, and the like, and required the student to specify the direction, distance, or speed of motion of some part, or some function of these. There were 30 items, and the time limit was 30 minutes.

13. Figure Classification, WNPA. This was a non-verbal reasoning test. In each item there were presented two groups of figures, labelled A and B, followed by five numbered single figures. The problem was to decide what characteristic all A figures had which no B figure had, and then to determine which one of the five numbered figures possessed this characteristic. There were 25 items, and the time limit was 20 minutes.

14. Figure Matrices, VDPH Book 3, Section IV. This was another non-verbal reasoning test. Each item consisted of a square divided into nine smaller squares. A geometric figure was presented in the square in the upper-left corner, and this figure changed in a systematic and logical fashion in the squares to the right and downward. The problem was to determine what kind of figure should consequently appear in the lower-right corner, which was always left not filled in. There were 20 items, and the time limit was 20 minutes.

15. Syllogisms, VDPH Book 3, Section V. This was a test of verbal reasoning ability, in which each item presented several possible conclusions from which the one was to be selected which followed most logically from the stated premises. There were 20 items. The time limit was 15 minutes.

16. Gottschaldt Figures, VDPH Book 3, Section III. This was a test of perception and visualization in which the student was called upon to state which one of five simple figures was contained in a complex figure, all figures being straight line geometrical ones. There were 15 items, and the time limit was 15 minutes.

17. Productivity of Ideas, VDPH Book 5, Section I, Part 2. The student was presented with a large number of lines each containing the statement, "It takes more than _____ to make a/an _____." He was told to fill these in as quickly as possible. The score was the number of statements completely filled in. The time limit was 7 minutes.

18. Related Words, WNPA. In this test the student was asked to think of a third word which was related in one way or another to each of two given words. The first letter of the correct word was given, and the student wrote out the rest of the word. There were 90 items, and the time limit was 15 minutes.

19. Topics, WNPA. This was a test which sought to measure how many ideas a student might think of concerning a particular topic, such as, "a train journey." Each idea was to be listed separately, and the score was the number of ideas written down. The time limit was 5 minutes.

20. Consequences, WNPA. In this test six statements were presented, each beginning, "What would happen if ....." The student was asked to write down in a brief, concise way what would happen as a consequence of the condition specified, using a separate short sentence for each idea. Each situation was given a time of 5 minutes, and the over-all time limit was 30 minutes. Five scores were derived from the answers: (1) Number of statements; (2) Number of these statements which were generalizations; (3) Number of these statements which were specific facts or concrete details; (4) Number of generalizations required to subsume all responses; and (5) Length of the longest run of consecutive, logically connected ideas.

Results of the Analyses

Two techniques were used for evaluating the effectiveness of a test in predicting the academic criterion of quality-point ratios. First, the range of scores for each test was broken into four parts, and the per cent of the group having scores in each quarter who had quality-point ratios of 2.00 or above was calculated. The resulting four percentages have been used to draw the charts presented as Figures 1-24. Secondly, there was computed for each test the coefficient of correlation between scores on the test and the quality-point ratios. These coefficients are given both below the titles of the figures, and, to make comparison of these easy, in Table 1 at the end of the report.

In these charts a highly discriminating test is one which shows a large percentage of quality-point ratios above 2.00 for persons having scores in the top range on the test, and a progressively smaller percentage of quality-point ratios

above 2.00 for persons having scores in each successively lower range of scores on the test, with the percentage for the lowest range of test scores quite small. Judged by this yardstick, the following tests have high discriminating ability:

Test 1: Engineering Achievement Test in Mathematics
Test 2: Physics Test
Test 3: G.R.E. Advanced Test in Engineering
Test 5: Reading Comprehension Test
Test 6: Mathematics Test from CEEB Scholastic Aptitude Test
Test 7: Mathematics Test, CEEB Intermediate Test

The following tests were found to have fair discriminating ability:

Test 8: Multiple Variates
Test 12: Mechanical Movements
Test 13: Figure Classification

Reference to Table 1 at the end of this report shows that the tests listed above are the tests which have the highest correlations with the quality-point ratio as the criterion. (This is to be expected.)

Conclusions

The charts presented in this report clearly demonstrate the high degree of effectiveness with which certain of the tests given in July 1948 have been found to predict academic performance in the first year at the Naval Postgraduate School. Tests of mathematical aptitude and mathematical achievement were shown to be particularly discriminating. The tests of engineering, reading comprehension, and physics were also found to be quite effective, though somewhat less so than the mathematics tests. Three other tests were found to possess fair discriminating ability, the Multiple Variates Test, the Mechanical Movements Test, and the Figure Classification Test.

The results of this assessment of the relationships of scores on the tests given in July 1948 to the quality-point ratios indicate that a very promising start has been made on the task of developing a battery of tests suitable for use as part of the means of selecting students for the Naval Postgraduate School.

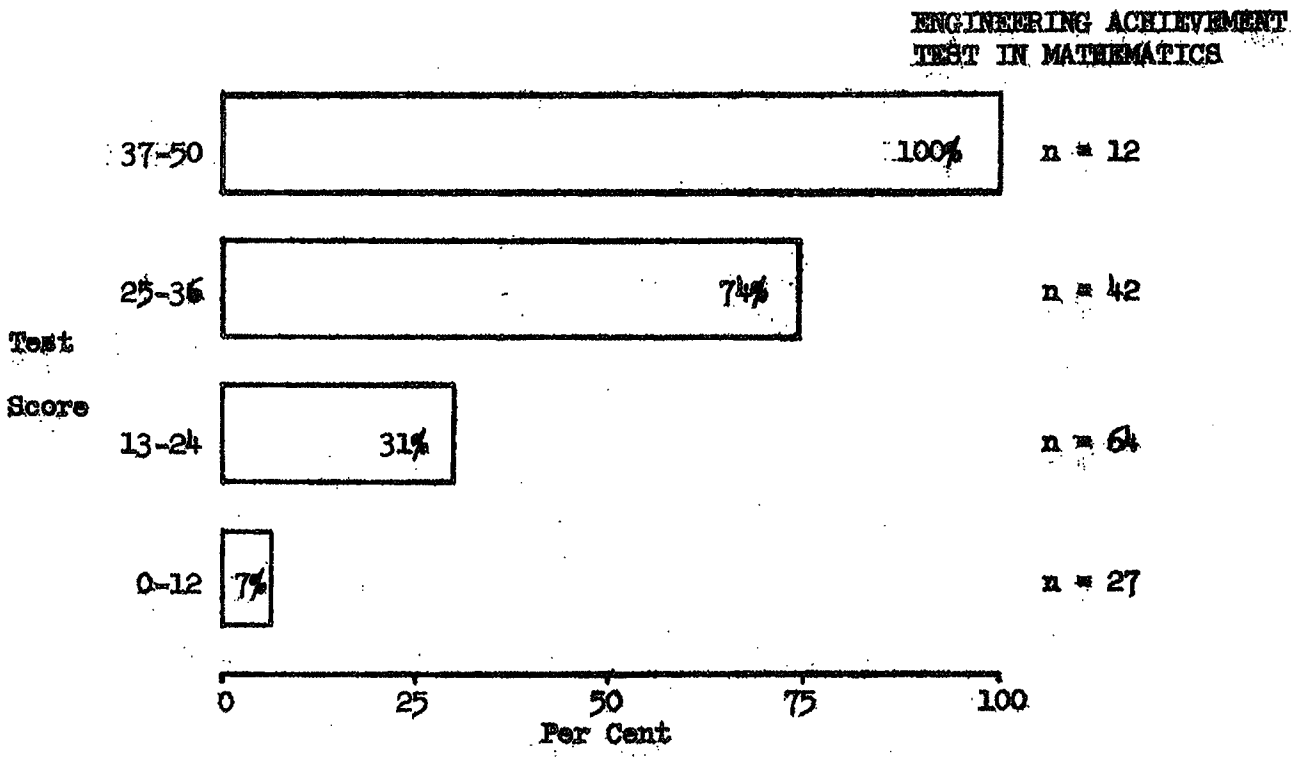

Figure 1. Per cent of students in each of four score ranges on the Engineering Achievement Test in Mathematics with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 21.0 S. D. = 9.9 Test-Q.P.R. Correlation = .76

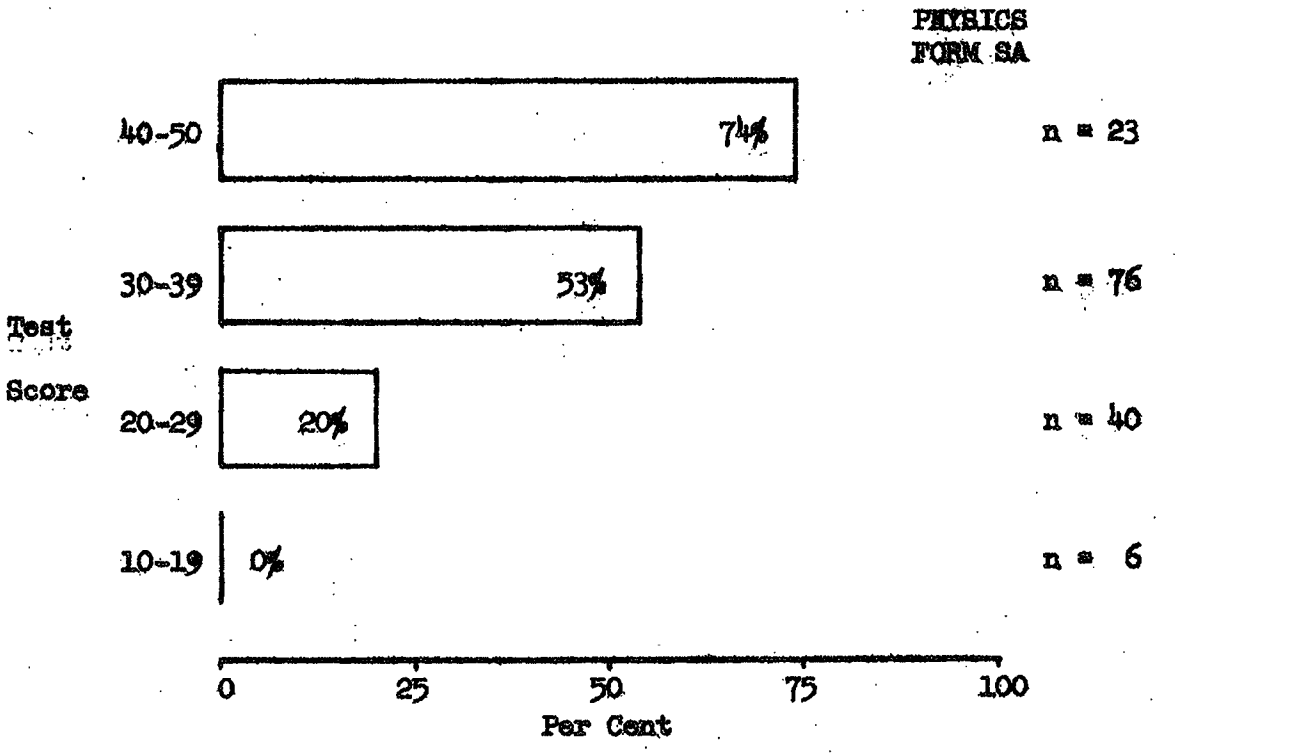

Figure 2. Per cent of students in each of four score ranges on the Physics Test, Form 5A, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 32.8 S. D. = 7.7 Test-Q.P.R. Correlation = .60

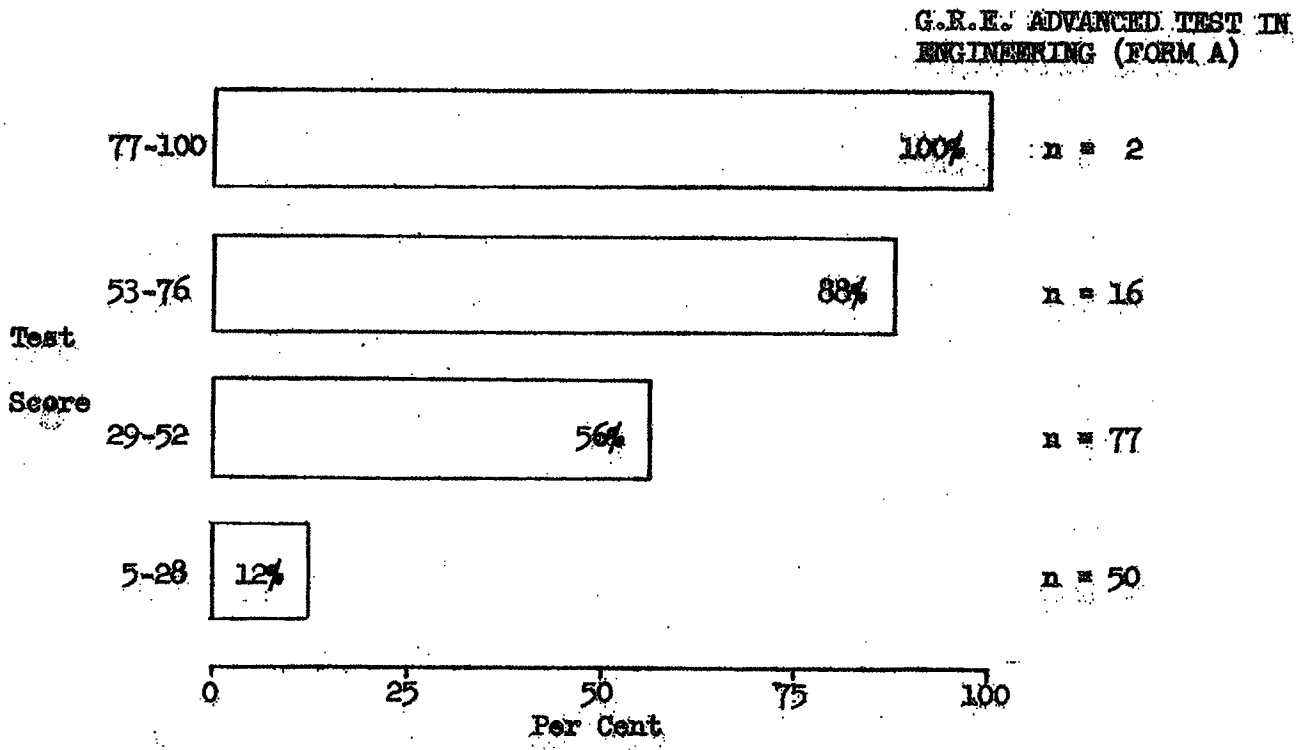

Figure 3. Per cent of students in each of four score ranges on the G.R.E. Advanced Test in Engineering (Form A) with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 35.8 S. D. = 14.8 Test-Q.P.R. Correlation = .52

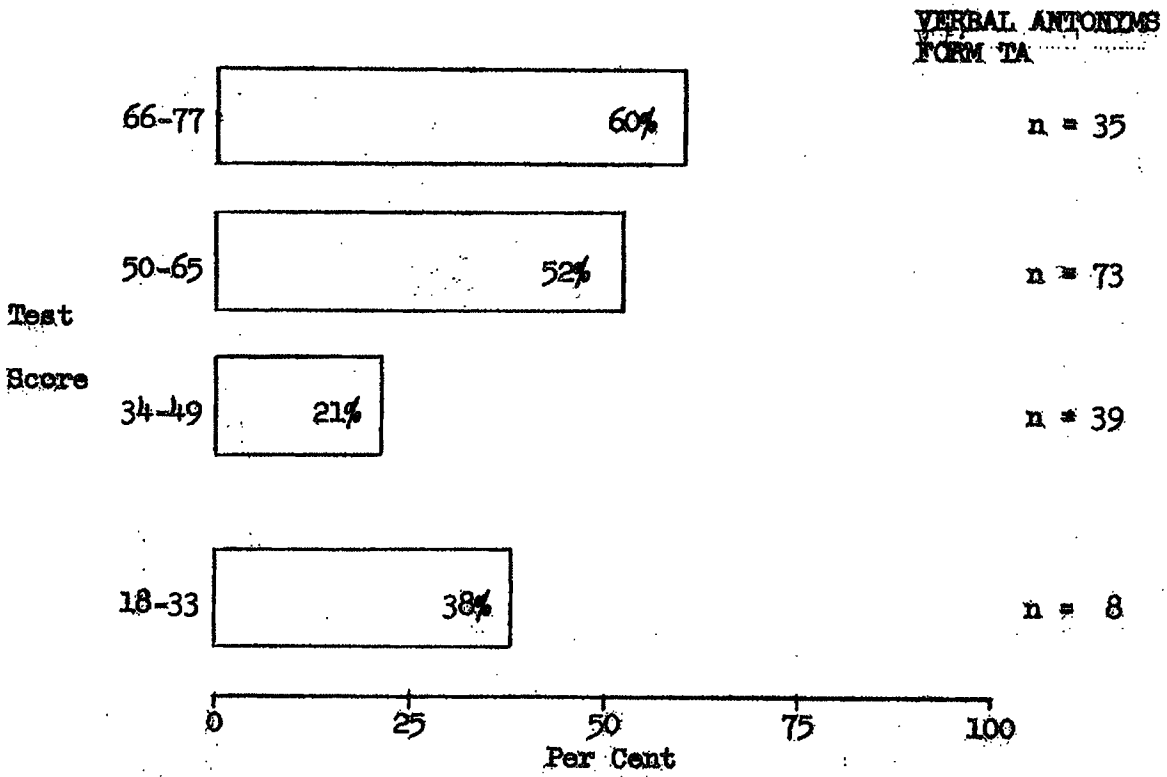

Figure 4. Per cent of students in each of four score ranges on the Verbal Antonym Test, Form TA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 55.0 S. D. = 13.0 Test-Q.P.R. Correlation = .32

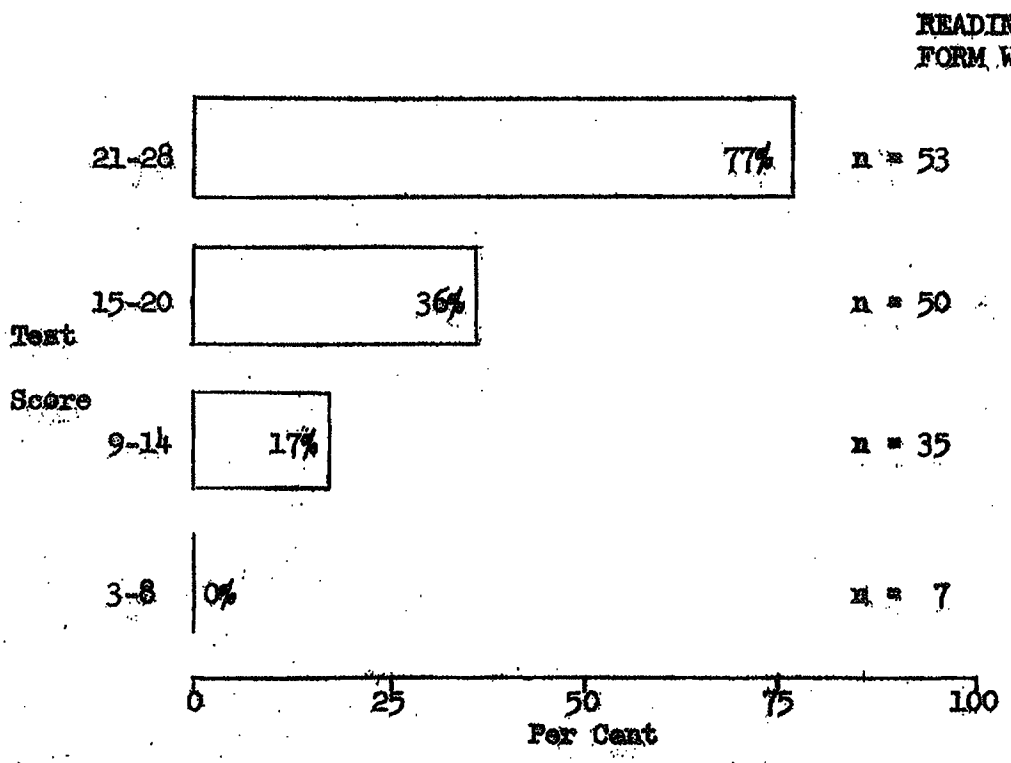

Figure 5. Per cent of students in each of four score ranges on the Reading Comprehension Test, Form WNPA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 18.0 S. D. = 5.5 Test-Q.P.R. Correlation = .44

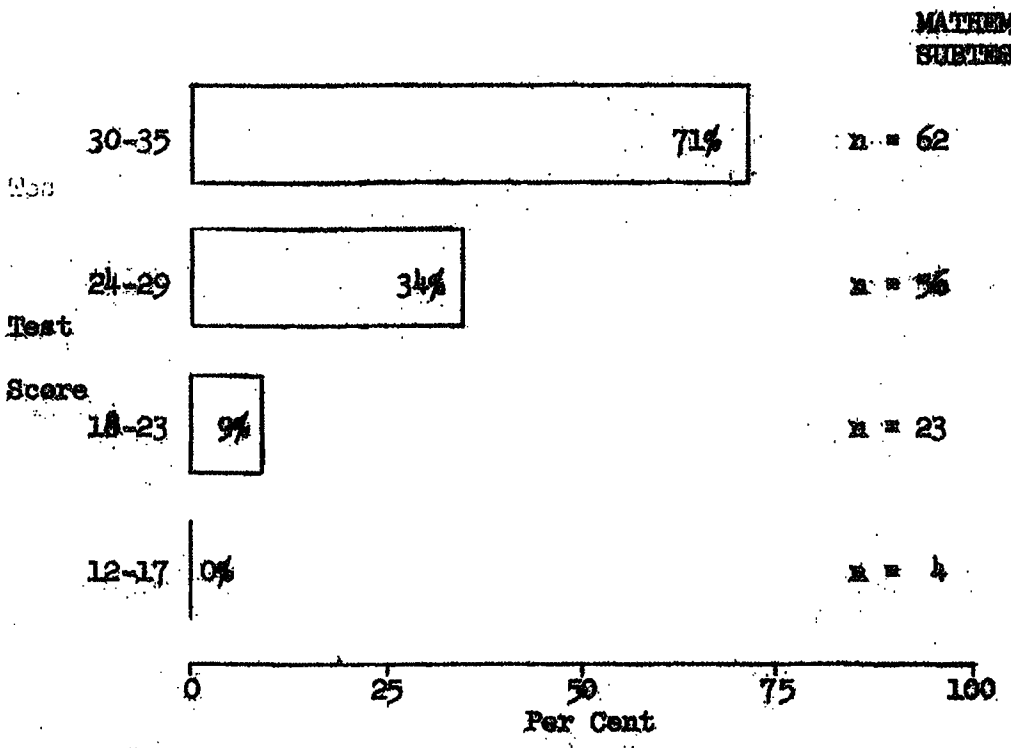

Figure 6. Per cent of students in each of four score ranges on the Mathematics Test, WSA2 Subtest 4, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 27.9 S. D. = 4.7 Test-Q.P.R. Correlation = .65

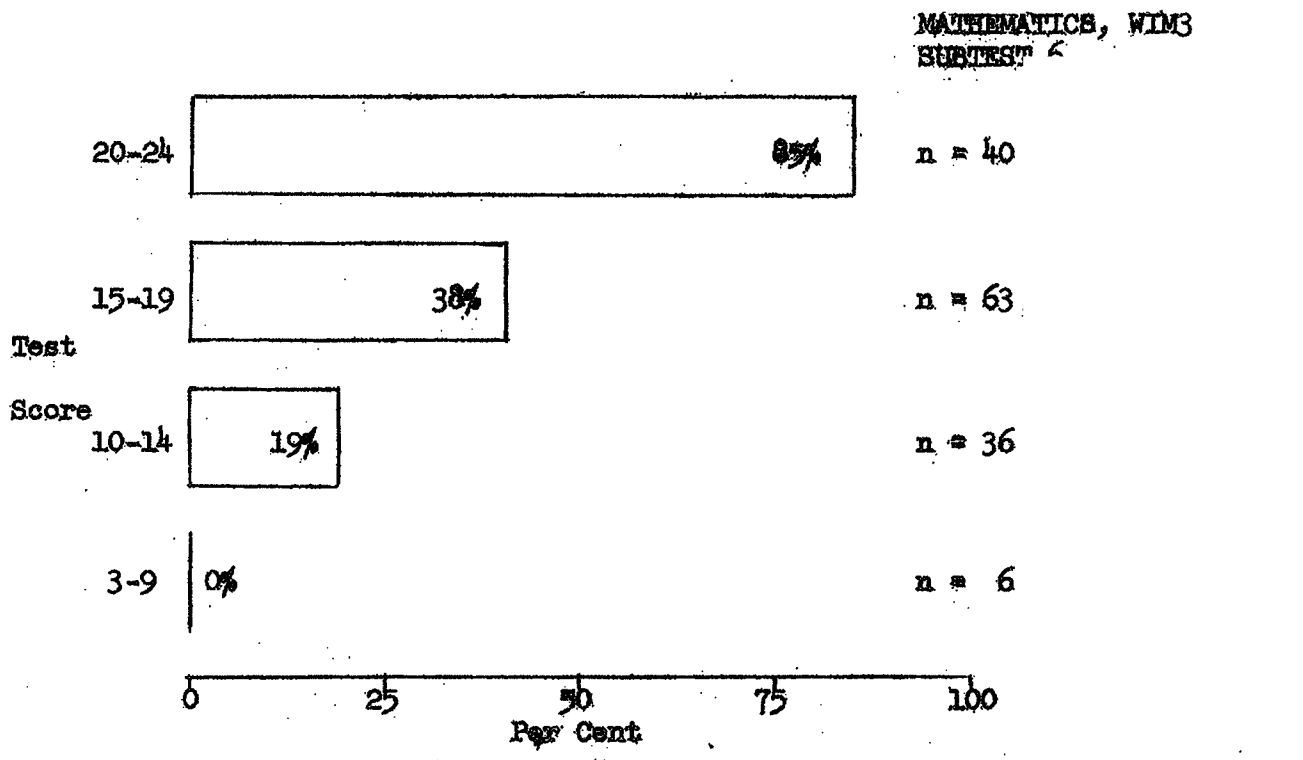

Figure 7. Per cent of students in each of four score ranges on the Mathematics Test, WIM3, Subtest 6, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 16.8 S. D. = 4.1 Test-Q.P.R. Correlation = .66

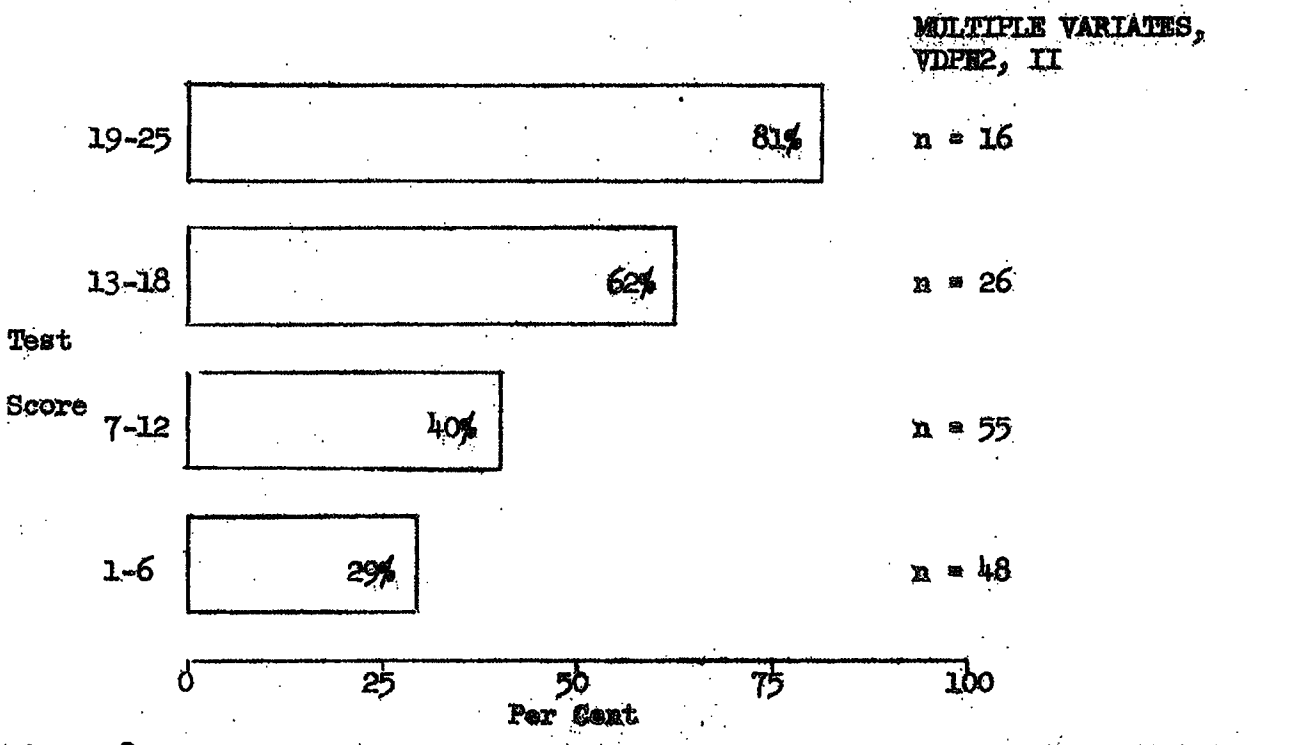

Figure 8. Per cent of students in each of four score ranges on the Multiple Variates Test, VDPM2, II, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 9.6 S. D. = 5.6 Test-Q.P.R. Correlation = .34

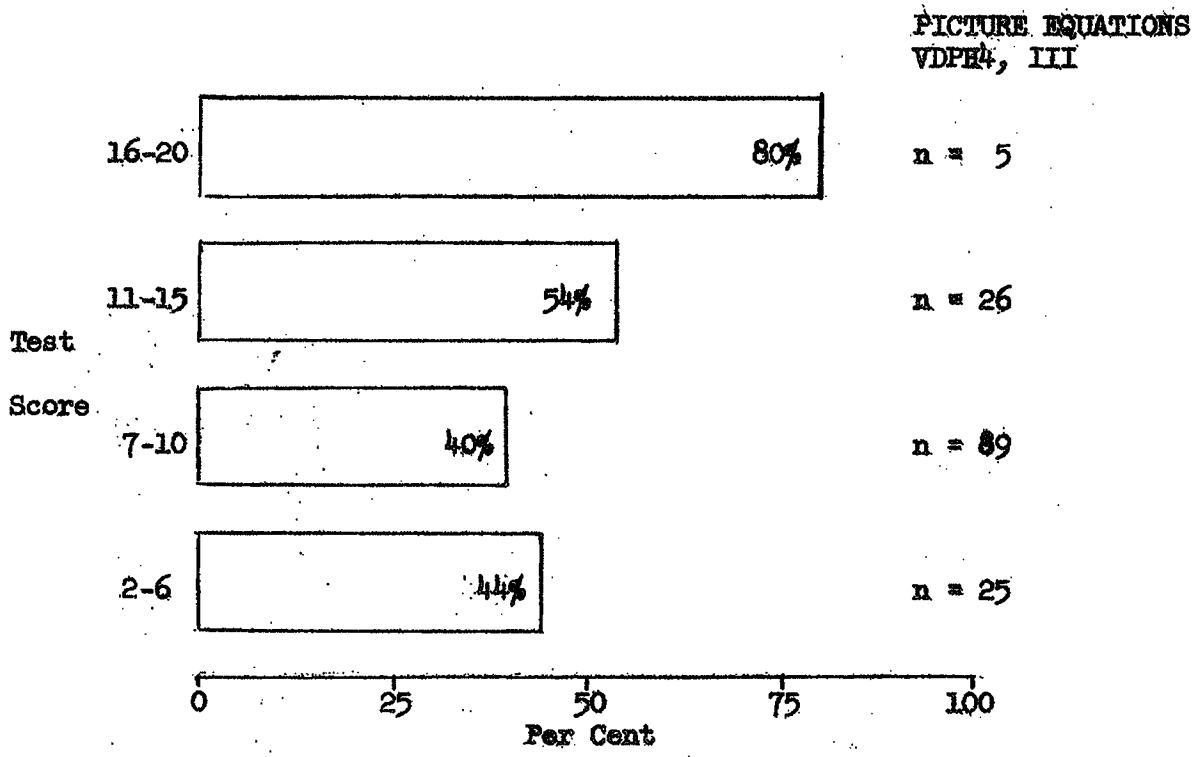

Figure 9. Per cent of students in each of four score ranges on the Picture Equations Test, VDPH4, III, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 8.8 S. D. = 3.0 Test-Q.P.R. Correlation = .32

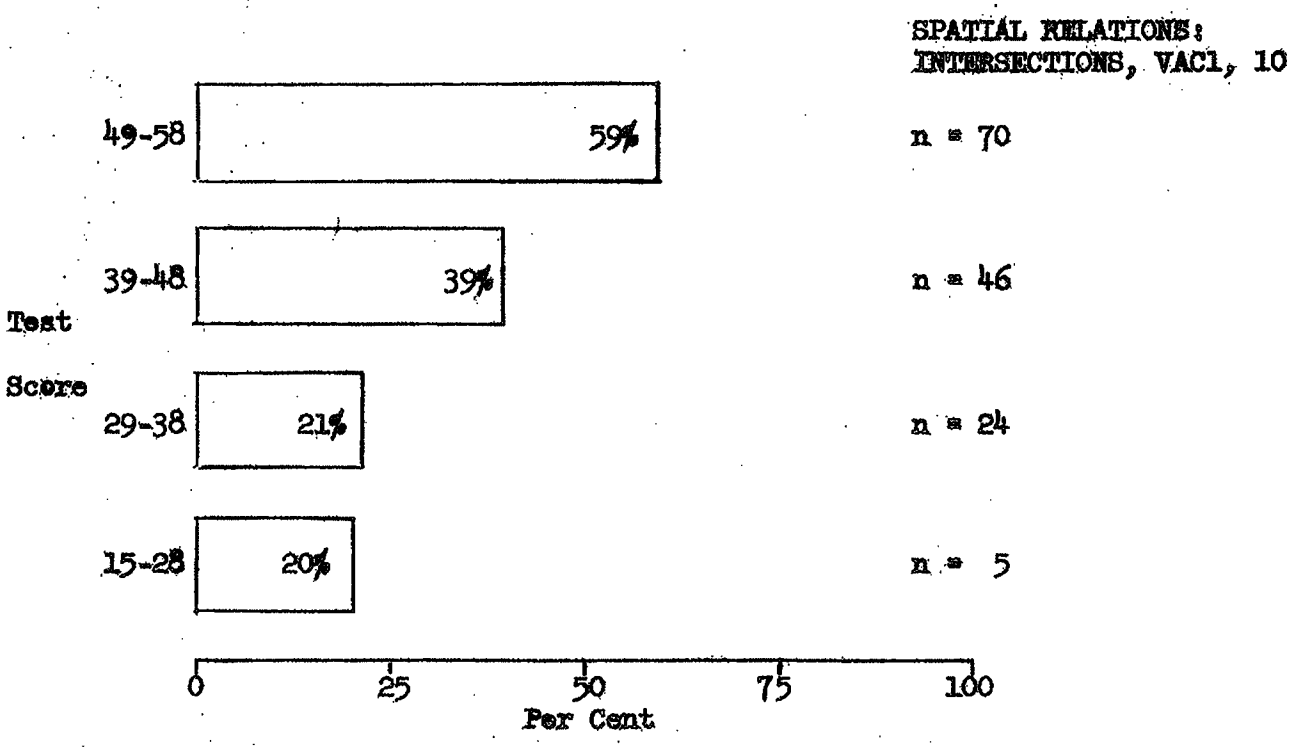

Figure 10. Per cent of students in each of four score ranges on the Spatial Relations: Intersections Test, VAC1, 10, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 45.8 S. D. = 8.1 Test-Q.P.R. Correlation = .25

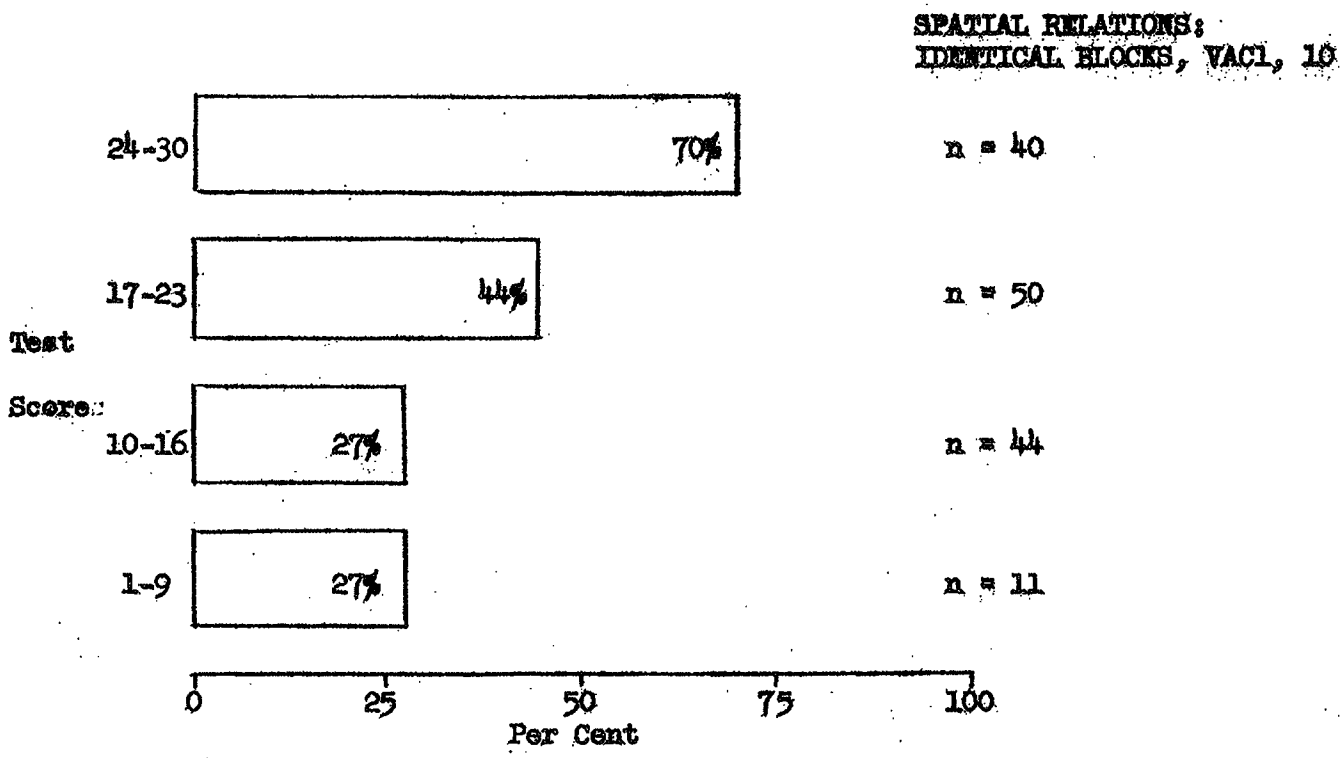

Figure 11. Per cent of students in each of four score ranges on the Spatial Relations: Identical Blocks Test, VAC1, 10, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 18.7 S. D. = 6.3 Test-Q.P.R. Correlation = .26

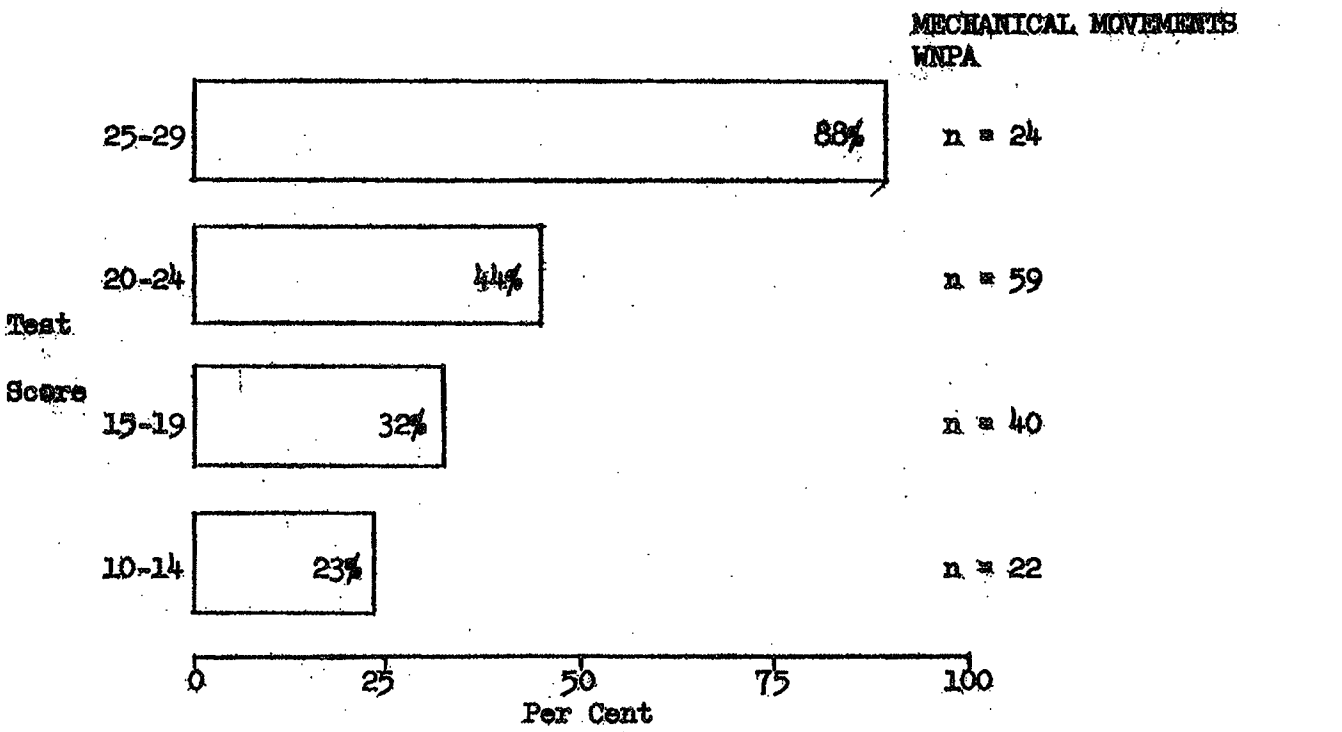

Figure 12. Per cent of students in each of four score ranges on the Mechanical Movements Test, WNPA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 20.0 S. D. = 4.4 Test-Q.P.R. Correlation = .34

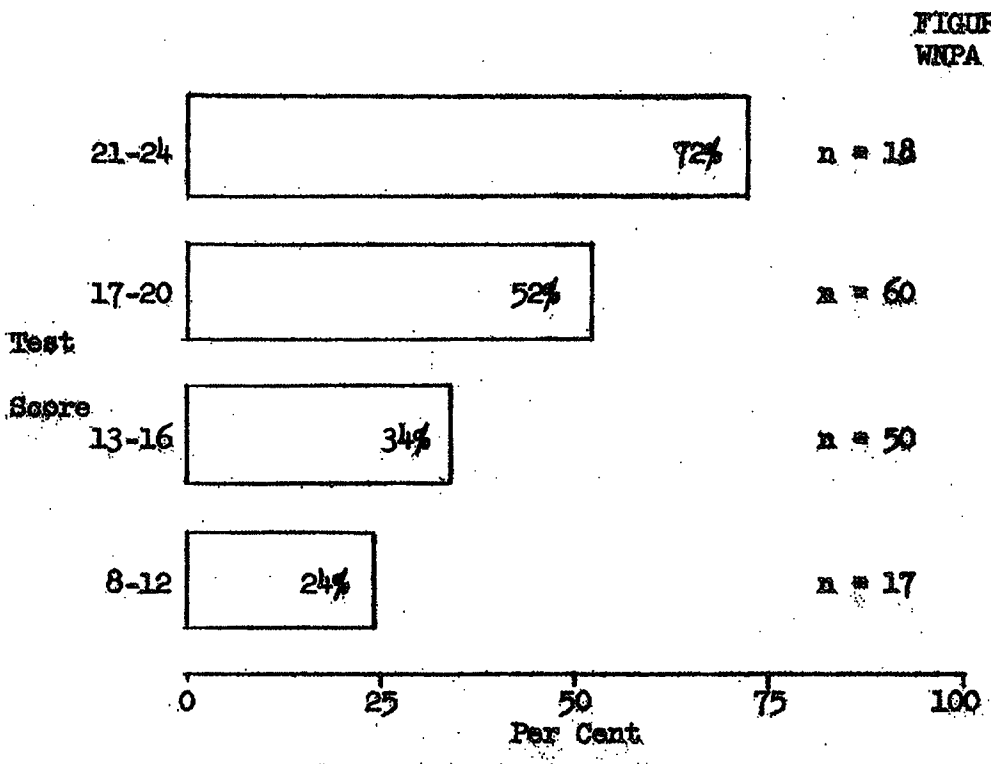

Figure 13. Per cent of students in each of four score ranges on the Figure Classification Test, WNPA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 16.7 S. D. = 3.2 Test-Q.P.R. Correlation = .30

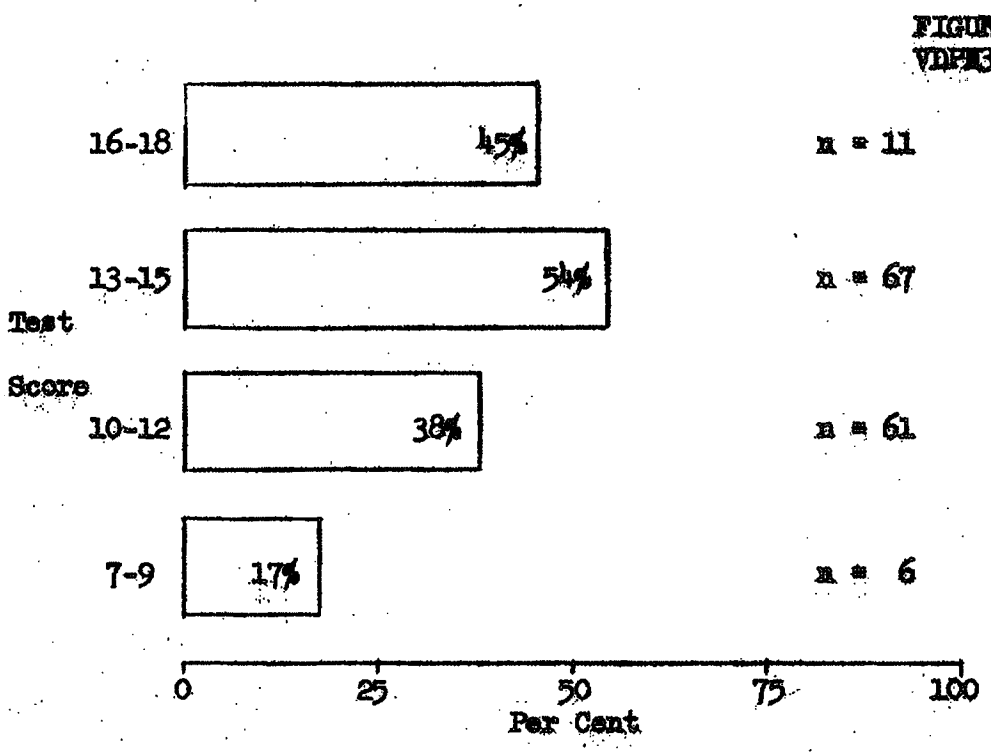

Figure 14. Per cent of students in each of four score ranges on the Figure Matrices Test, VDPM3, IV, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 12.8 S. D. = 2.0 Test-Q.P.R. Correlation = .21

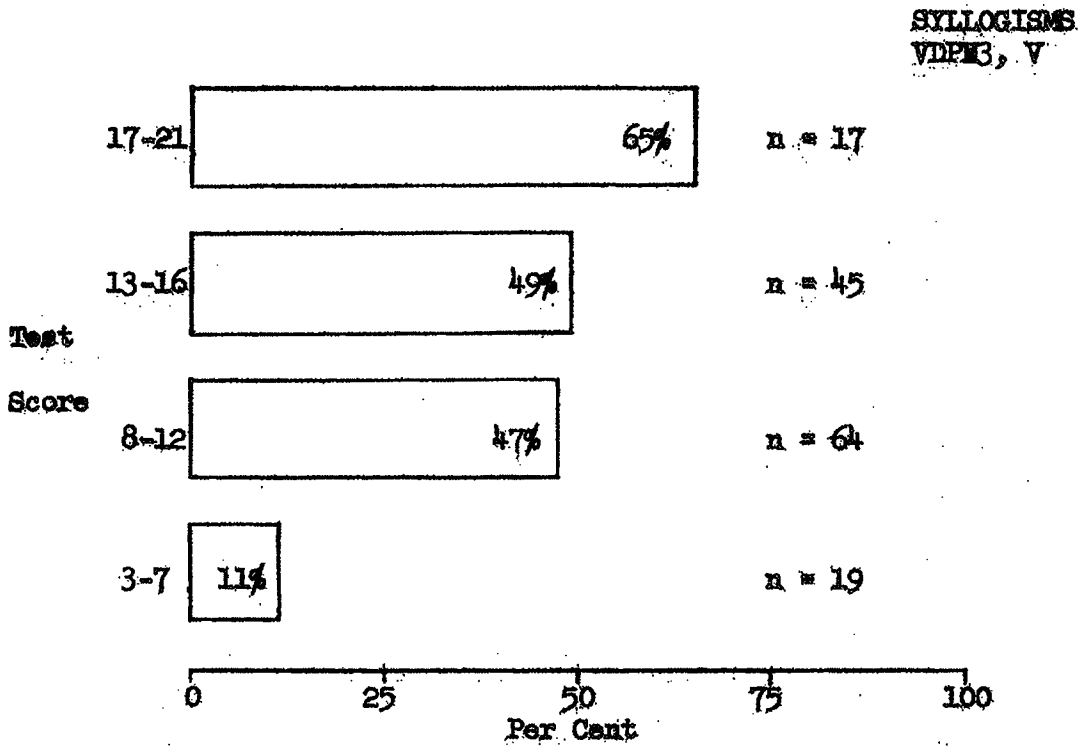

Figure 15. Per cent of students in each of four score ranges on the Syllogisms Test, VDPH3, V, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 11.7 S. D. = 3.9 Test-Q.P.R. Correlation = .29

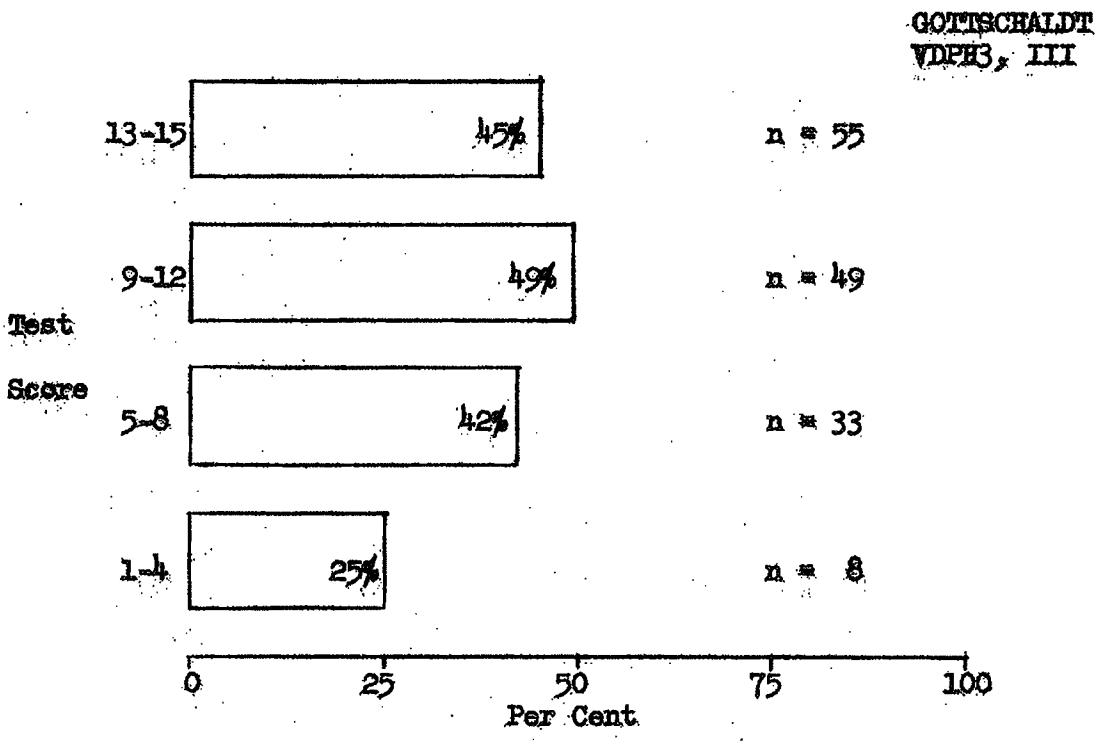

Figure 16. Per cent of students in each of four score ranges on the Gottschaldt Figures Test, VDPH3, III, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 10.5 S. D. = 3.4 Test-Q.P.R. Correlation = .07

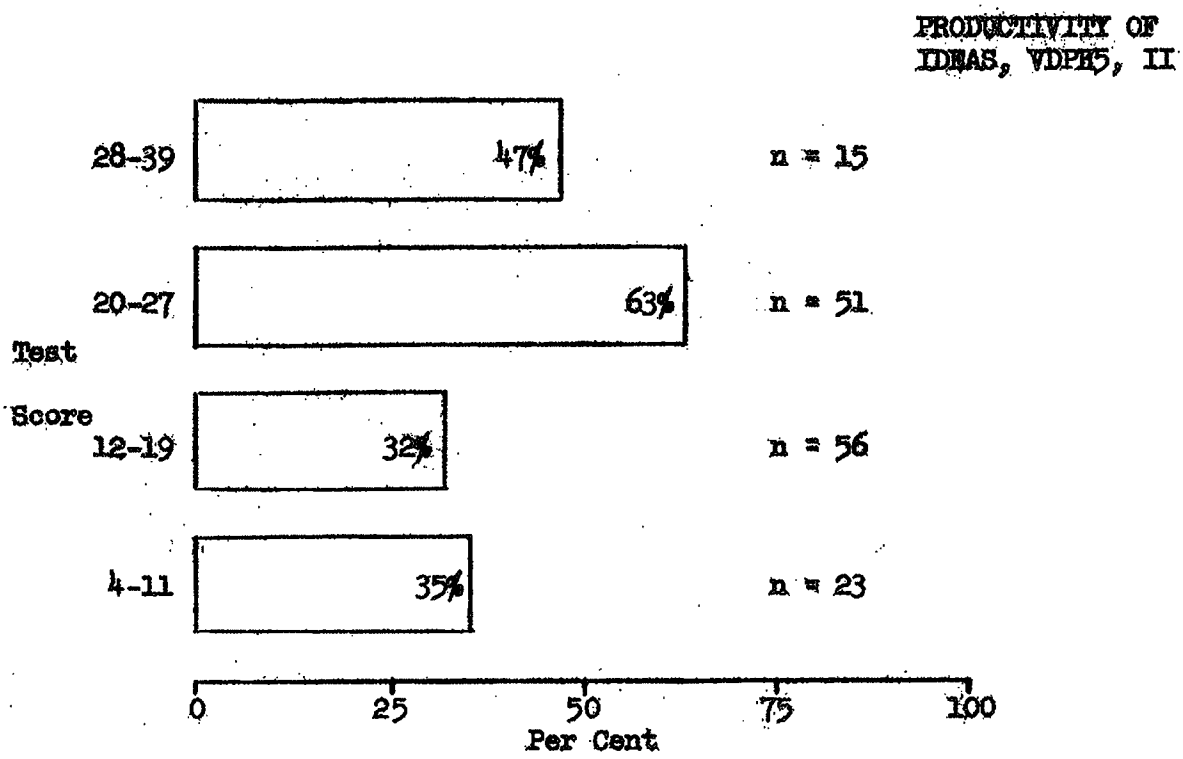

Figure 17. Per cent of students in each of four score ranges on the Productivity of Ideas Test, VDPE5, II, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 19.2 S. D. = 6.8 Test-Q.P.R. Correlation = .16

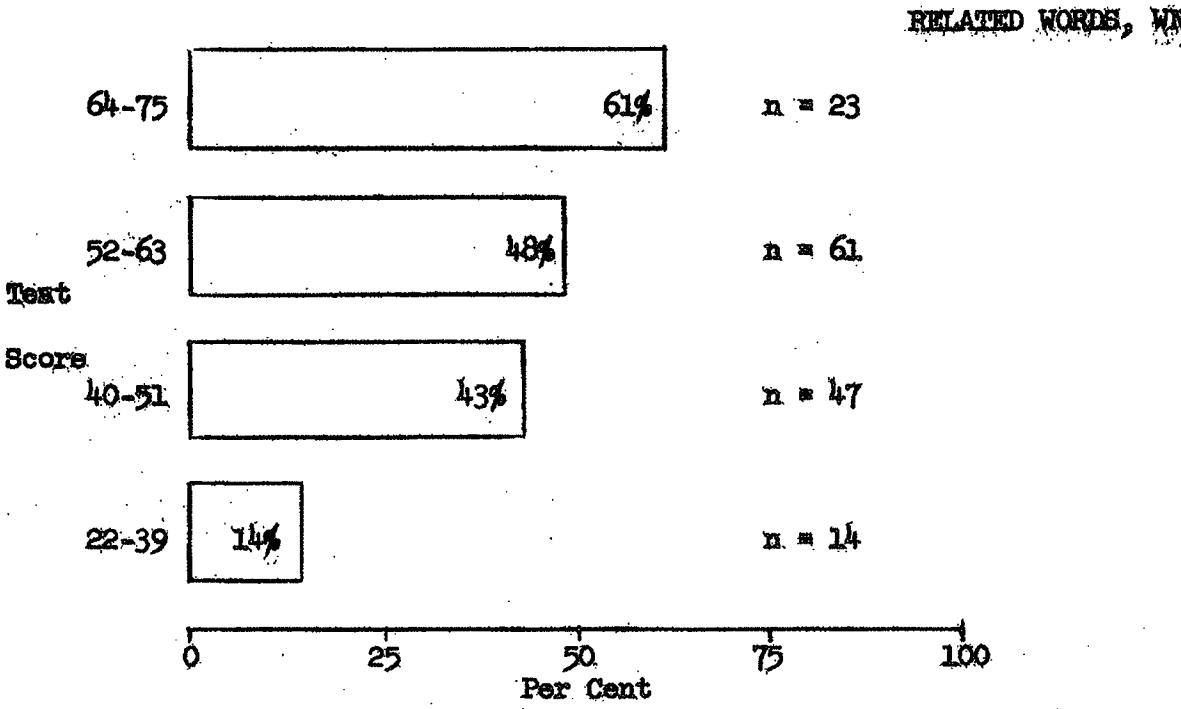

Figure 18. Per cent of students in each of four score ranges on the Related Words Test, WNPA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 53.4 S. D. = 10.3 Test-Q.P.R. Correlation = .22

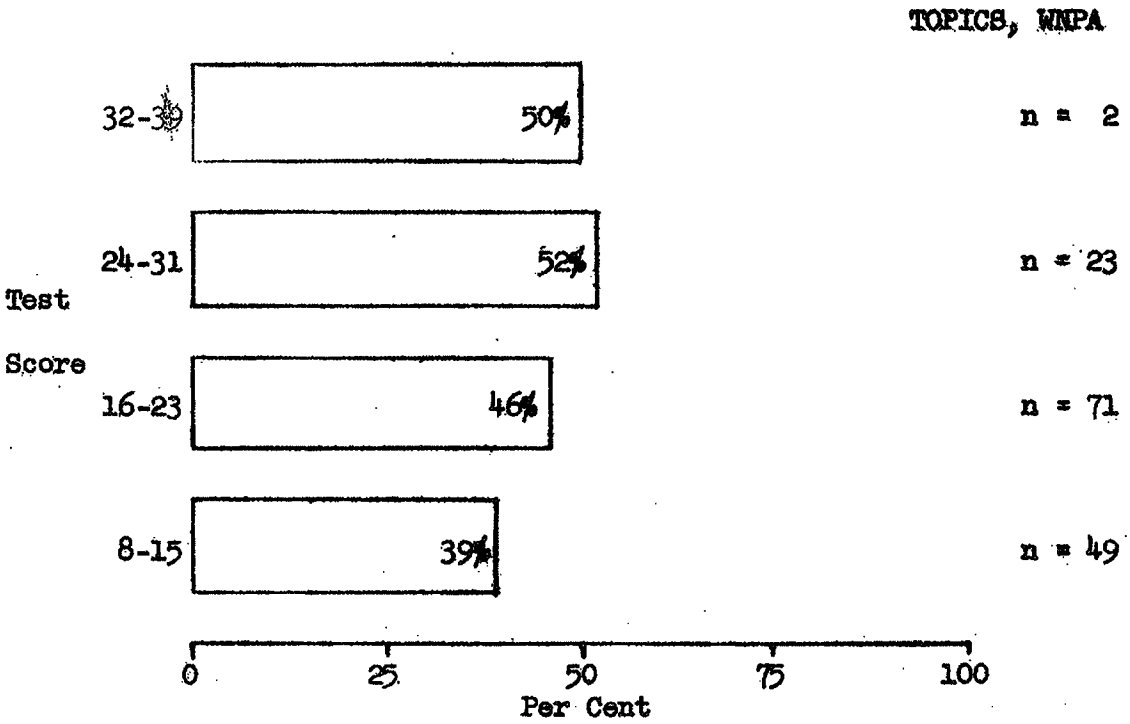

Figure 19. Per cent of students in each of four score ranges on the Topics Test, WNPA, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 18.0 S. D. = 5.4 Test-Q.P.R. Correlation = .18

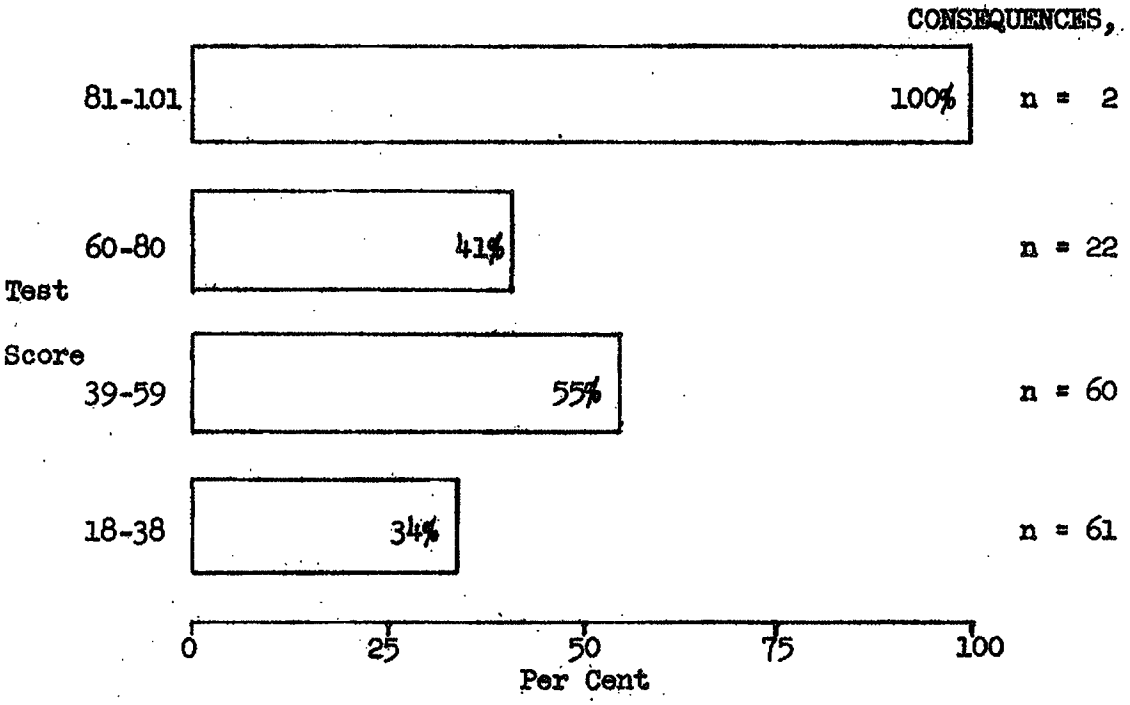

Figure 20. Per cent of students in each of four score ranges on the Consequences Test, Score 1, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 43.8 S. D. = 15.1 Test-Q.P.R. Correlation = .24

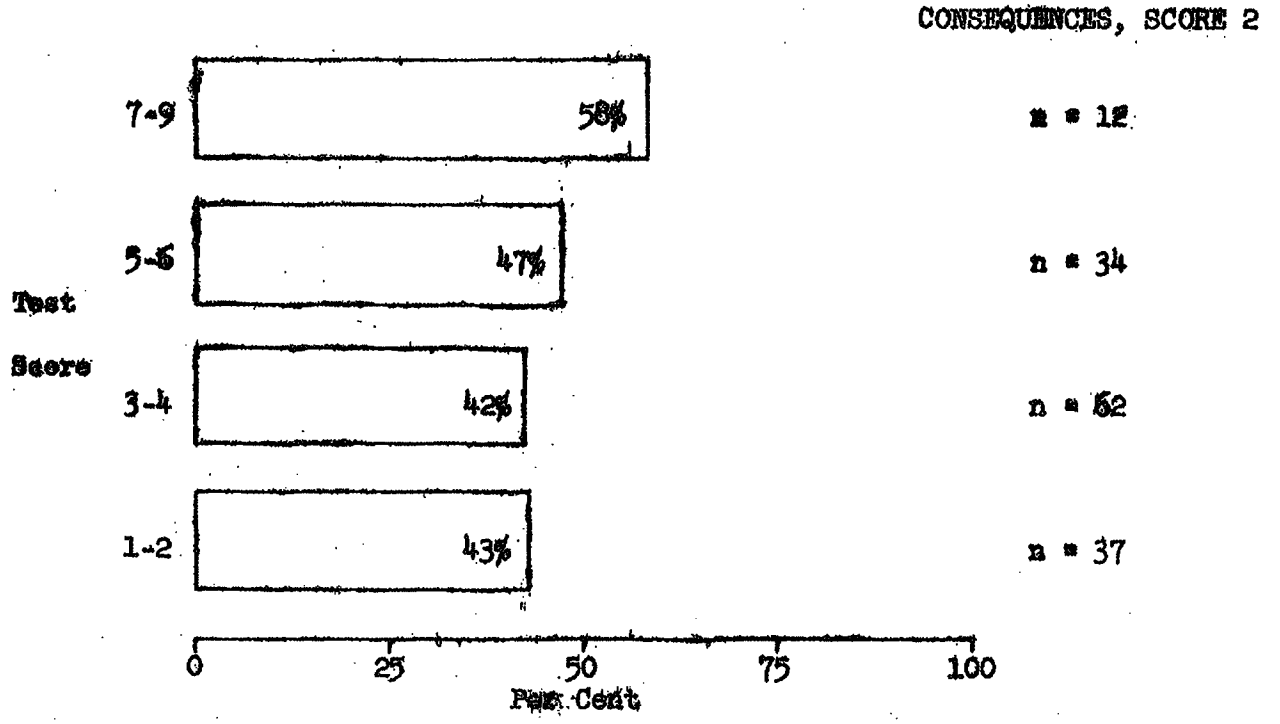

Figure 21. Per cent of students in each of four score ranges on the Consequences Test, Score 2, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 3.8 S. D. = 1.8 Test-Q.P.R. Correlation = .01

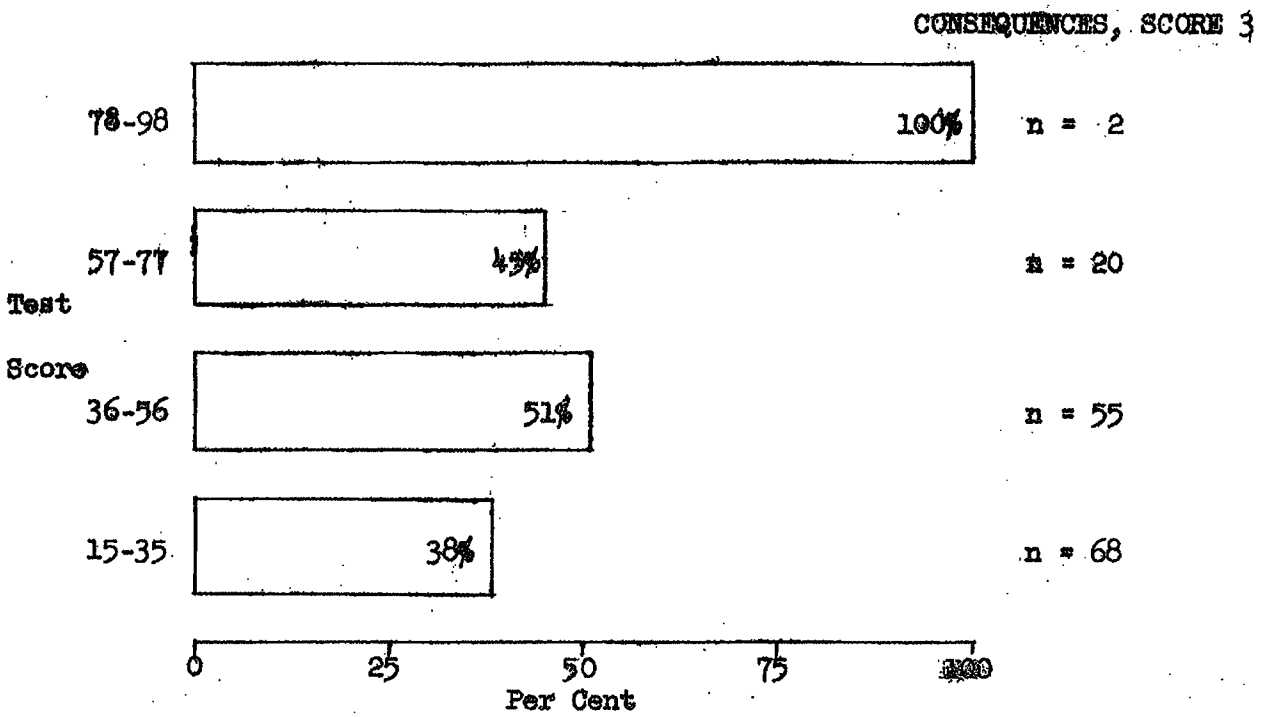

Figure 22. Per cent of students in each of four score ranges on the Consequences Test, Score 3, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 40.0 S. D. = 14.6 Test-Q.P.R. Correlation = .26

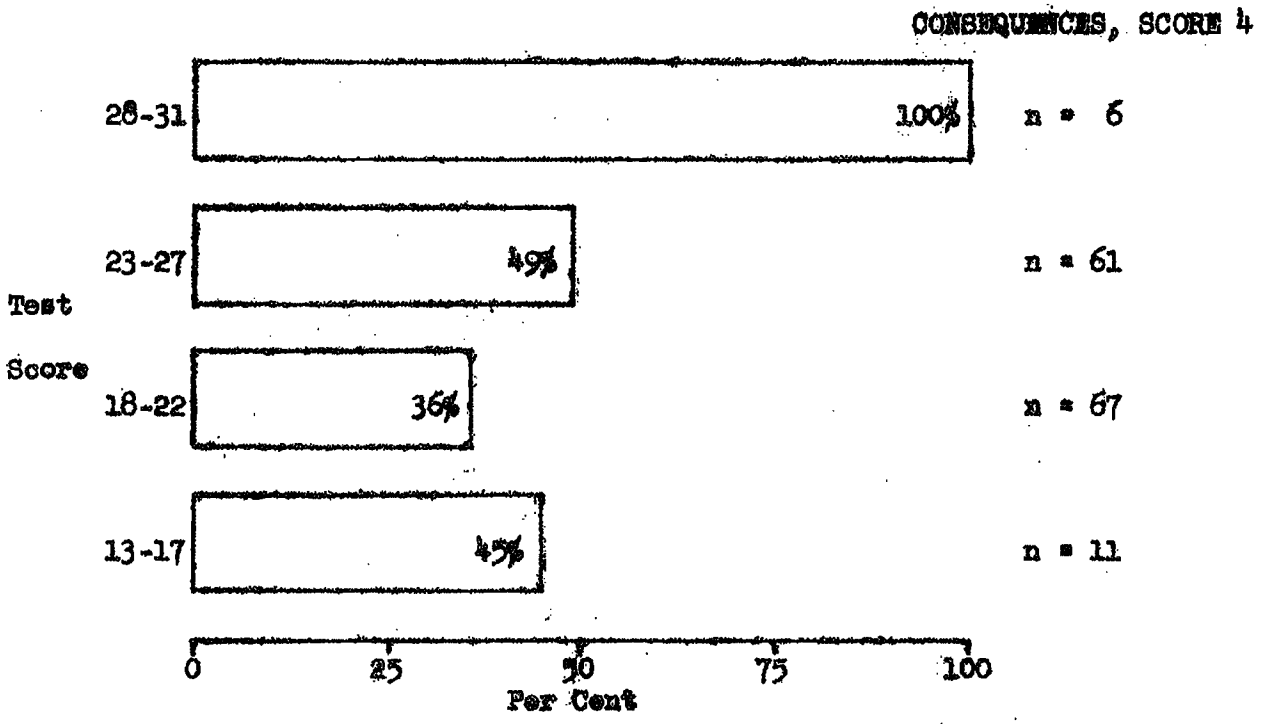

Figure 23. Per cent of students in each of four score ranges on the Consequences Test, Score 4, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 22.0 S. D. = 3.4 Test-Q.P.R. Correlation = .26

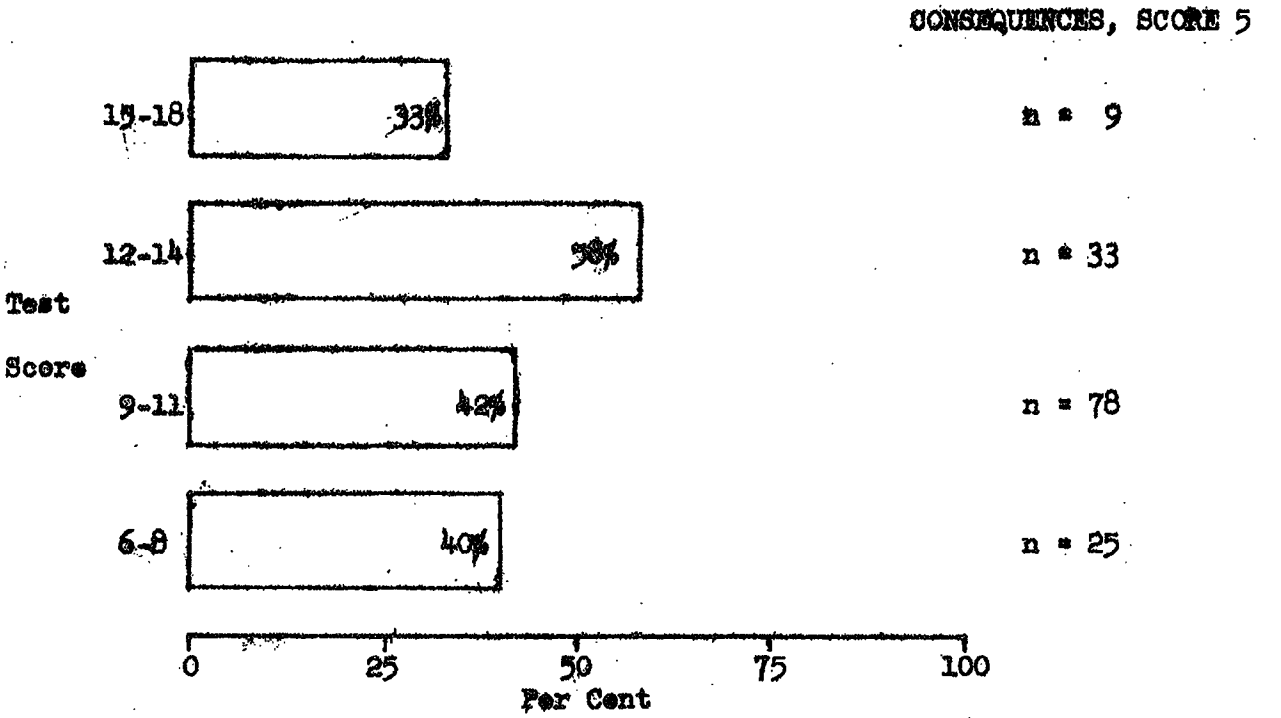

Figure 24. Per cent of students in each of four score ranges on the Consequences Test, Score 5, with Quality-Point Ratios above 2.00
N = 145 Mean Test Score = 10.6 S. D. = 2.2 Test-Q.P.R. Correlation = .07

Table 1

Product-Moment Correlation of Scores on Tests in July 1948 Battery with Criterion of Quality-Point Ratio for Entire First Year at the Naval Postgraduate School, with Means and Standard Deviations

Test	Mean	Standard Deviation	Correlation with Quality-Point Ratio
1. Engineering Achievement Test in Mathematics	21.0	9.9	.76*
2. Physics Test, Form SA	32.8	7.7	.60*
3. G.R.E. Advanced Test in Engineering (Form A)	35.8	14.8	.52*
4. Verbal Antonyms, Form TA	55.0	13.0	.32*
5. Reading Comprehension, Form WNPA	18.0	5.5	.44*
6. Mathematics Test, WSA2, Subtest 4	27.9	4.7	.65*
7. Mathematics Test, WIM3, Subtest 6	16.8	4.1	.66*
8. Multiple Variates, VDPH2, II	9.6	5.6	.34*
9. Picture Equations, VDPH4, III	8.8	3.0	.32*
10. Spatial Relations: Intersections, VAC1, 10	45.8	8.1	.25*
11. Spatial Relations: Identical Blocks, VAC1, 10	18.7	6.3	.26*
12. Mechanical Movements, WNPA	20.0	4.4	.34*
13. Figure Classification, WNPA	16.7	3.2	.30*
14. Figure Matrices, VDPH3, IV	12.8	2.0	.21*
15. Syllogisms, VDPH3, V	11.7	3.9	.29*
16. Gottschaldt Figures, VDPH3, III	10.5	3.4	.07
17. Productivity of Ideas, VDPH5, I	19.2	6.8	.16
18. Related Words, WNPA	53.4	10.3	.22*
19. Topics, WNPA	18.0	5.4	.18
20. Consequences, Score 1	43.8	15.1	.24*
21. Consequences, Score 2	3.8	1.8	.01
22. Consequences, Score 3	40.0	14.6	.26*
23. Consequences, Score 4	22.0	3.4	.26*
24. Consequences, Score 5	10.6	2.2	.07

Mean of Q. P. R. = 1.88

Standard Deviation = 0.69

N = 145

*A validity coefficient as great as this would occur by chance less than once in a hundred times when the true correlation was zero, for an N of 145.